

## Research Article

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# Assessment of quality of irrigation water of Kachchh district of Gujarat

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### Summary

A survey of quality of irrigation water was carried out by Agriculture Research Station, S. D. Agricultural University, Bhachau- Kachchh during 2009-10. Total 369 water samples were collected from 10 different talukas of Kachchh district for assessment of quality of irrigation water. RSC of most of water sample were observed safe (88.89%), only 5.15 and 5.96 per cent sample were categorized under marginal and unsafe. RSC level was in order. Mundra > Mandvi > Bhuj. Chloride concentration of Kachchh district water samples were observed in order Mandvi > Gandhidham > Mundra > Bhachau > Rapar. Soluble salt was observed in order Mundra > Rapar > Mandvi > Gandhidham > Abdasa. In case of sodium hazard Mundra > Mandvi > Abdasa.

**Key words :** Sodium adsorption ratio (SAR), Residual sodium carbonate (RSC), Quality of irrigation water

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## Introduction

Kachchh is a largest district (45,625 km) of Gujarat state. It lies at 22° 44' 11" to 24° 41' 25" North latitude and 68° 09' 46" to 71° 54' 47" East Longitude. Out of 679936 ha of cultivated land, 178029 ha (26.18%) are irrigated land. The remaining land (73.82%) is unirrigated one. Only Mundra, Bhuj and Nakhatrana taluka stand good at more than 60 per cent of their land under 'irrigated' category. However, in Gandhidham, only 3 per cent of cultivable lands are irrigated with open wells and tube wells which are important source of irrigation.

Quality of irrigation water plays a vital role in crop production. Under the application of good quality water we have choice to grow any crop and their varieties without any limitations. Under the application of poor

irrigation water we have to take care because it not only decreases the crop production but also spoil the soil health i.e. physical, chemical and biological properties of soil. Accumulation of excess salts in soils and consequent development of salinity and sodicity in soils is common in arid and semi arid regions. Groundwater irrigation deteriorates the soil quality when it is rich in soluble salts and residual sodium carbonate (RSC). Irrigation with such waters lead to secondary salinization, deterioration in soil properties, restricted availability of major and micronutrients and reduction in crop yields (Gupta *et al.*, 2000 and Joshi and Bohra, 2009). Deficiency and status of micronutrients have been reported in soils of India (Takkar and Randhawa, 1978; Rattan and Sharma, 2004). Due to presence of salt affected soils and poor quality water of Kachchh district it is necessary to

determine the interfering elements responsible for reduction in crop growth, yield and quality. So present study was conducted in which we collected the water samples from various villages of entire talukas of Kachchh and analyzed them.

In order to assess the quality of irrigation water and their suitability and unsuitability to the crops 369 water samples from the wells and tube wells of various villages of all the ten talukas of Kachchh district (Gujarat) were collected. The experiment was conducted during 2008-09 to 2011-12 at Agricultural Research Station, Sardarkrushinagar Dantiwada Agricultural University, Bhachau, Kachchh. After collection and labeling of samples all the samples were filtered using filter. The water samples were analyzed for EC, pH,  $\text{Ca}^{++}$ ,  $\text{Mg}^{++}$ ,  $\text{Na}^{+}$ ,  $\text{CO}_3^{--}$ ,  $\text{HCO}_3^{-}$ ,  $\text{Cl}^{-}$  and  $\text{F}^{-}$  by adopting standard procedures and further the sodium adsorption ratio (SAR) and residual sodium carbonate (RSC) values of the samples were calculated and interpreted based on their suitability and unsuitability to the crops. Similar kind of

work has been reported by Kumar and Sharma (2010).

## Resource and Research Methods

Total 369 water samples were collected from different 10 talukas of Kachchh district of Gujarat. Before monsoon collected, filtered and stored in plastic bottle and standard method of analysis of different constitute were used and analyzed the sample.

The pH of water sample was determined by using glass electrode pH meter and electrical conductivity was determined by using EC meter (Jackson, 1973), sodium ( $\text{K}^{+}$ ) content in water samples was determined by using flame photometer (Jackson, 1973), carbonate, chloride and sulphate ( $\text{CO}_3^{--}$ ,  $\text{Cl}^{-}$  and  $\text{SO}_4^{--}$ ) were determined by the Mohr's titration method (Richards, 1954).

## Research Findings and Discussion

Among all talukas of Kachchh district, the water samples of Mundra taluka had highest mean EC. pH,

**Table 1 : Range and mean values of EC, pH, Na and Ca+Mg, in water samples of different talukas of Kachchh district**

Sr. No.	Taluka	No. of samples	EC $\mu\text{mhos/cm}$		pH		Na (mel/l)		Ca+Mg (mel/l)	
			Range	Mean	Range	Mean	Range	Mean	Range	Mean
1.	Bhachau	44	1200-8100	2999.27	7.27-8.98	8.22	3.61- 48.35	21.21	3.0-52.9	14.05
2.	Rapar	68	450-11200	3994.68	7.25-8.90	8.00	1.65-71.91	30.47	3.2-60.5	26.04
3.	Abdasa	40	710-10000	3550.25	7.85-9.28	8.47	13.30-73.78	29.82	2.9-21.9	10.73
4.	Lakhpath	49	700-6900	3448.57	7.77-8.99	8.25	8.26-71.91	34.50	3.0-46.2	23.01
5.	Nakhtrana	28	700-5000	2378.57	7.45-8.89	8.32	13.3-40.96	22.74	5.5-30.2	12.83
6.	Anjar	36	680-5000	2174.44	8.00-8.72	8.35	4.17-49.35	15.64	4.0-26.9	8.52
7.	Bhuj	38	690-4900	2414.47	7.13-9.17	8.36	3.3-39.96	14.20	2.0-27.3	9.44
8.	Mundra	30	1700-11900	4469.48	8.15-9.36	8.54	15.7-66.09	35.65	3.6-45.4	10.14
9.	Mandvi	28	1400-10500	4350.22	7.98-9.30	8.52	1.61-73.00	33.82	1.5-34.7	10.39
10.	Gandhidham	08	1100-4500	3487.5	8.1-9.05	8.40	19.04-38.91	28.77	2.9-17.7	10.64
	District	369								

**Table 2: Range and mean values of  $\text{CO}_3+\text{HCO}_3$ , Cl, and F content in water samples of different talukas of Kachchh district**

Sr. No.	Taluka	No. of samples	$\text{CO}_3+\text{HCO}_3$ (meq/l)		Cl (meq/l)		F (ppm)	
			Range	Mean	Range	Mean	Range	Mean
1.	Bhachau	44	0.6-4.95	2.38	4.0-30.5	13.94	0.25-1.50	0.68
2.	Rapar	68	0.4-3.41	1.67	0.75-80.5	21.64	0.2-1.47	0.69
3.	Abdasa	40	0.99-5.45	2.95	3.5-54.25	19.04	0.25-1.48	0.73
4.	Lakhpath	49	0.4-8.11	2.36	0.8-65.75	22.59	0.25-1.46	0.77
5.	Nakhtrana	28	1.3-6.71	3.30	3.2-26.25	12.48	0.2-1.45	0.54
6.	Anjar	36	1.1-6.72	3.16	3.7-30.25	10.04	0.35-1.25	0.62
7.	Bhuj	38	1.0-11.38	3.34	3.1-26.25	10.70	0.22-1.42	0.52
8.	Mundra	30	1.1-6.16	3.45	4.5-38.75	23.26	0.2-1.25	0.49
9.	Mandvi	28	0.9-7.8	3.42	3.0-71.25	23.64	0.2-1.3	0.52
10.	Gandhidham	08	0.98-5.2	2.42	7-45.75	18.71	0.45-1.48	0.81
	District	369						

Na and  $\text{CO}_3+\text{HCO}_3$  which was followed by Mandvi taluka and Rapar taluka had highest amount of Ca+Mg followed by Lakhpath taluka (Table 1). Highest mean chloride was found in samples of Mandvi taluka which was followed by Mundra taluka. Highest mean fluoride was found in Gandhidham taluka followed by Lakhpath and Abdasa taluka. Two samples of Rapar taluka and one samples of Lakhpath taluka were found above the critical limits (Table 2).

RSC of most of the water samples of Kachchh was observed safe (88.89%), only 5.15 and 5.96 per cent samples are categorized under Marginal and unsafe categories, respectively. Samples of Mundra taluka have highest percentage of RSC levels followed by Mandvi

and Bhuj talukas (Table 5).

Chloride concentration of Kachchh water samples were high, among all samples, 25.56, 24.14, 27.64, 13.83 and 7.86 per cent samples were categorized under unsafe, doubtful, permissible, good and excellent categories, respectively. Highest unsafe chloride concentration was found in Mandvi taluka followed by Gandhidham, Mundra, Bhachau and Rapar talukas, respectively (Table 6).

Water samples of Kachchh district had high soluble salts which have 63.29, 32.52 and only 3.79 per cent samples under very high salinity, high salinity and medium salinity classes, respectively and non of the samples was found under low salinity category. Highest salinity was

**Table 3 : Distribution of water samples according to total concentration of soluble salts ( $\mu\text{mhos/cm}$ ) in different talukas of Kachchh district**

Sr. No.	Taluka	No. of samples	EC ( $\mu\text{mhos/cm}$ )			
			0-250	250-750	750-2250	>2250
			C <sub>1</sub> -Low salinity	C <sub>2</sub> -Medium salinity	C <sub>3</sub> -High salinity	C <sub>4</sub> - Very high salinity
1.	Bhachau	44	-	02 (4.5)	14 (31.82)	28 (63.64)
2.	Rapar	68	-	02 (2.94)	14 (20.59)	52 (76.47)
3.	Abdasa	40	-	02 (5)	09 (22.5)	29 (72.5)
4.	Lakhpath	49	-	02 (4.08)	15 (30.61)	32 (65.31)
5.	Nakhtrana	28	-	02 (7.14)	12 (42.86)	14 (50)
6.	Anjar	36	-	03 (8.33)	19 (52.78)	14 (38.88)
7.	Bhuj	38	-	01 (2.63)	21 (55.26)	16 (42.11)
8.	Mundra	30	-	-	07 (23.34)	23 (76.64)
9.	Mandvi	28	-	-	07 (25)	21 (75)
10.	Gandhidham	08	-	-	02 (25)	06 (75)
	District	369	-	14 (3.79)	120 (32.52)	235 (63.69)

Bracket value shows the percentage distribution of water samples

**Table 4 : Distribution of water samples accords to sodium hazards (SAR) in different talukas of Kachchh district**

Sr. No.	Taluka	No. of samples	SAR			
			0-10	10-18	18-26	>26
			S <sub>1</sub> -Low sodium hazard	S <sub>2</sub> -Medium sodium hazard	S <sub>3</sub> -High sodium hazard	S <sub>4</sub> - Very high sodium hazard
1.	Bhachau	44	30 (68.18)	11(25)	03(6.82)	-
2.	Rapar	68	48(70.59)	17(25)	03(4.41)	-
3.	Abdasa	40	13(32.5)	18(45)	8(20)	01(2.5)
4.	Lakhpath	49	23(46.94)	26(53.06)	-	-
5.	Nakhtrana	28	16(57.14)	12(42.86)	-	-
6.	Anjar	36	31(86.11)	5(13.89)	-	-
7.	Bhuj	38	32(84.21)	05(13.16)	01(2.63)	-
8.	Mundra	30	03(10)	09(30)	16(53.33)	02(6.67)
9.	Mandvi	28	09(32.14)	06(21.73)	11(39.29)	02(3.57)
10.	Gandhidham	08	02(25)	4(50)	02(25)	-
	District	369	207(56.10)	113(30.62)	44(11.92)	05(1.36)

Bracket value shows the percentage distribution of water samples

recorded in Mundra taluka followed by Rapar, Mandvi, Gandhidham and Abdasa talukas, respectively (Table 3).

56.10 per cent samples of Kachchh district were found having low sodium hazards ( $S_1$ ), 30.62 per cent under medium sodium hazards, 11.92 per cent high sodium hazards and only 1.36 per cent samples were found under sodium category. Among all talukas Mundra taluka had highest sodium hazards which was followed by Mandvi and Abdasa (Table 4).

Under ground water of Kachchh district had high soluble salts, among these samples 63.29 per cent samples had very high salinity ( $C_4$  class), 32.52 per cent had high salinity ( $C_3$ ) and only 3.79 per cent samples were found under medium salinity classes. Among all talukas of Kachchh district, Mundra had highest salinity

(76.64%) which was followed by Rapar (76.47%), Mandvi and Gandhidham (75%), Lakhpath (65.31%), Bhachau (63.64%) Nakhtrana (50%), Bhuj (42.11%) and Anjar (38.88%) (Table 3).

This study concluded that Kachchh water samples had less sodium hazards compared to salinity hazards because it had 56.10, 30.65 11.93 and 1.36 per cent samples under low, medium, high and very high categories, respectively. Among all talukas Mundra (53.33%) had highest sodium hazards followed by Mandvi (39.29%), Gandhidham (25%) and Abdasa (20%) (Table 4). RSC of most of the water samples of Kachchh were observed safe (88.89%), only 5.15 and 5.96 per cent samples were categorized under marginal and unsafe categories, respectively (Table 5). Chloride

Table 5 : Distribution of water samples according to bicarbonate hazards (meq/l) in different talukas of Kachchh district						
Sr. No.	Taluka	No. of samples	RSC (meq/l)			
			<1.25	1.25-2.5	>2.5	
			Safe	Marginally safe	Unsafe	
1.	Bhachau	44	40	02	02	
2.	Rapar	68	63	02	03	
3.	Abdasa	40	37	02	1	
4.	Lakhpath	49	47	02	-	
5.	Nakhtrana	28	26	01	01	
6.	Anjar	36	33	03	-	
7.	Bhuj	38	31	03	04	
8.	Mundra	30	21	03	06 (20)	
9.	Mandvi	28	22	01	05	
10.	Gandhidham	08	08	-	-	
	District	369	328 (88.89)	19 (5.15)	22 (5.96)	

Value shown in bracket indicates percentage distribution of samples

Table 6 : Distribution of water samples according to chloride concentration (meq/l) in different talukas of Kachchh district							
Sr. No.	Taluka	No. of samples	Cl (meq/l)				
			0-4	4-7	7-12	12-20	>20
			Excellent	Good	Permissible	Doubtful	Unsafe
1.	Bhachau	44	2 (4.55)	3 (6.82)	15 (34.09)	10 (22.72)	14 (31.82)
2.	Rapar	68	3 (4.41)	4 (5.88)	18 (26.47)	22 (32.86)	21 (30.88)
3.	Abdasa	40	2 (5)	5 (12.5)	10 (25)	11 (27.5)	12 (30)
4.	Lakhpath	49	2 (4.08)	5 (10.3)	12 (24.49)	15 (27.5)	15 (30)
5.	Nakhtrana	28	2 (7.14)	6 (21.43)	12 (42.86)	5 (17.86)	3 (10.71)
6.	Anjar	36	6 (16.67)	10 (27.10)	10 (27.10)	7 (19.44)	3 (8.33)
7.	Bhuj	38	7 (18.42)	8 (21.05)	10 (26.32)	8 (21.05)	5 (13.16)
8.	Mundra	30	2 (6.67)	4 (13.33)	8 (26.67)	6 (20)	10 (33.13)
9.	Mandvi	28	3 (10.71)	5 (17.86)	5 (17.86)	3 (10.71)	12 (42.86)
10.	Gandhidham	08	-	01 (12.5)	02 (25)	02 (25)	03 (37.5)
	District	369	29 (7.86)	51 (13.82)	102 (27.64)	89 (24.12)	98 (25.56)

Value shown in bracket indicates percentage distribution of samples

concentration of Kachchh water samples was high, among all samples 25.56, 24.14, 27.64, 13.83 and 7.86 per cent samples were categorized under unsafe, doubtful, permissible, good and excellent categories, respectively. None of the water samples of Kachchh had fluoride content above critical limit ( $<1.5\text{PPm}$ ) (Table 6).

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